A story about
Belief and Evidence

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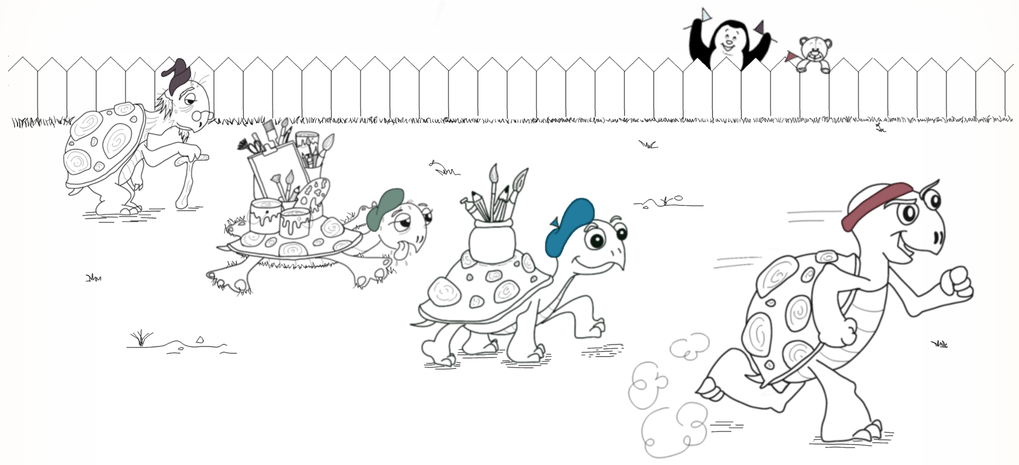
SAME EVIDENCE, DIFFERENT BELIEFS

It is curious how small changes in our experiences can generate completely different personalities. Two siblings who belong to the same culture, the same family and have very similar stimuli, may have completely opposite likes. Something similar happens with evidence.

The same piece of evidence can generate different beliefs depending on the agent. Take a newspaper, for example. We all read the same news, but we all draw different conclusions. Trying to capture every possible idiosyncrasy seems undoable. However, we can make it simple: the same piece of evidence does not support a single way of thinking. This idea motivates the second aspiration of my PhD project. We are working on a model where not only the quality of the evidence matters, but also the stance of the agent and the context they find themselves in. Agents will have the same arguments, but each one will determine which type of argument is good enough to justify a certain belief.

From your point view, how different can two beliefs based on the same evidence be?



A COMPUTATIONAL COMPLEXITY ANALYSIS

My phone's memory is full of fancy recipes that I have found on the internet. However, at dinner time simplicity and convenience win. Following the metaphor, we would like to develop a model that is useful at the end of the day. That is why studying its computational properties is in our agenda.

In this direction, we have obtained some results by studying the computational complexity of Dempster's rule of combination ("Using Hierarchies to Efficiently Combine Evidence with Dempster's Rule of Combination", UAI 2022).

Although computing Dempster's rule of combination is generally #P-hard (Orponen, 1990), there are some cases where this rule can be used in polynomial time. For instance when the set of evidence has a hierarchical structure (Shafer and Logan, 2008).

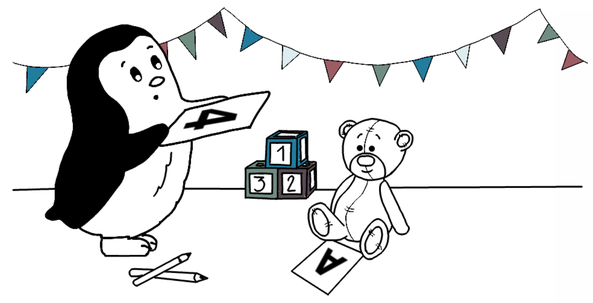
We proved that deciding whether a set of evidence has a hierarchical structure is als polynomial-time solvable. In addition, we showed that the general case is fixed-parameter-tractable, where the parameter captures how far the set of evidence is from being a hierarchy.

How would you efficiently combine evidence?

COMPUTING BELIEF FROM EVIDENCE

"You'd have to see it to believe it",
it is said.

This popular saying shows the base of what epistemologists call evidence-based belief, that is, the belief we build on evidence.



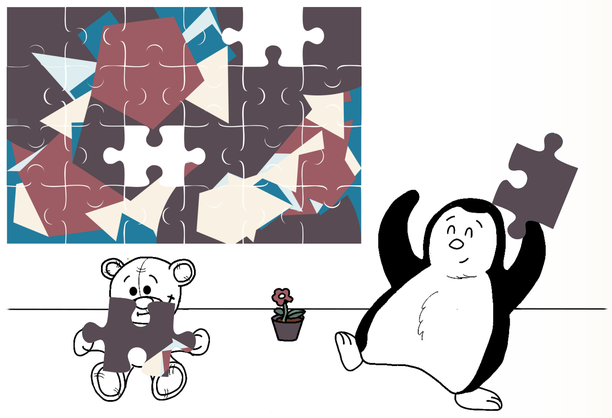
However, this evidence does not come from an omniscient being. It may be contradictory, uncertain, or simply wrong.

Traditionally, evidence can be modeled by following either a qualitative or a quantitative approach. Depending on how we decide to model our evidence, encoding desirable properties may turn to be challenging. For example, in "Justified Belief and the Topology of Evidence", Baltag et al. (2016) proposed a qualitative approach that handles contradictions very well, but cannot express uncertainty about evidence. On the other hand, some quantitative approaches successfully deal with this kind of uncertainty but struggle with contradictions. One example is Dempster-Shafer Theory. My PhD projesct brings these two approaches together, aiming to get the best of both worlds.

Which approach works better for you, quantitative or qualitative?

AN EPISTEMIC LOGIC

Being aware of our beliefs is not enough. Believing that it is necessary to take care of our planet is good, but thinking about it when deciding which means of transportation to use is even better. Therefore, giving the agents the possibility to compute the logical consequences of their beliefs is essential.



After defining a model which computes a degree of belief considering evidence, agents, and contextual properties, we are providing it with a logic. While we want this logic to be Boolean, we would also like to capture the notion of degree of belief.

To this end, we gave the agents the possibility to express whether they believe more in one proposition or in another one. We also made sure the agents cannot believe in contradictory propositions, even if these have a certain degree of belief.

Which type of logic would you use to make the agents reason about their beliefs?

Design: Arthur Boixel